

WHAT IS CLAIMED IS:

1. A ball-limiting metallurgy, comprising:
a substrate;
a barrier layer formed over the substrate;
5 an adhesion layer formed over the barrier layer;
a first solderable layer formed over the adhesion
layer;

a diffusion barrier layer formed over the adhesion
layer; and

10 a second solderable layer formed over the diffusion
barrier layer.

2. The ball-limiting metallurgy of claim 1, wherein
the first solderable layer is made of copper.

15 3. The ball-limiting metallurgy of claim 2, wherein
the diffusion barrier layer is made of CoWP.

4. The ball-limiting metallurgy of claim 1, wherein
20 the second solderable layer is made of Ni.

5. The ball-limiting metallurgy of claim 1, wherein
the barrier layer, the adhesion layer, the first solderable

layer, the diffusion barrier layer, and the second solderable layer are surrounded by a polyimide layer.

6. An interconnection structure for flip-chip attachment of microelectronic device chips to packages, comprising:

a ball-limiting metallurgy comprising:

a barrier layer formed over the microelectronic device chip;

an adhesion layer formed over the barrier layer;

a first solderable layer formed over the adhesion layer;

a diffusion barrier layer formed over the adhesion layer; and

a second solderable layer formed over the diffusion barrier layer; and

at least one lead-free solder ball formed over the second solderable layer.

7. The interconnection structure of claim 6, wherein the first solderable layer is made of copper.

8. The interconnection structure of claim 7, wherein the diffusion barrier layer is made of CoWP.

9. The interconnection structure of claim 6, wherein the second solderable layer is made of Ni.

5 10. The interconnection structure of claim 6, wherein the barrier layer, the adhesion layer, the first solderable layer, the diffusion barrier layer, and the second solderable layer are surrounded by a polyimide layer.

10 11. The interconnection structure of claim 6, wherein the at least one lead-free solder ball is made of a tin alloy.

12. A method for forming an interconnection structure for flip-chip attachment of microelectronic device chips to packages, comprising:

forming a barrier layer over a substrate;

forming an adhesion layer over the barrier layer;

forming a resist layer over the adhesion layer, the resist layer having an opening that exposes the adhesion layer;

forming a first solderable layer over the adhesion layer through the opening in the resist layer;

forming a diffusion barrier layer over the first
solderable layer through the opening in the resist layer;

forming a second solderable layer over the diffusion
barrier layer through the opening in the resist layer;

5 removing the resist layer;

removing portions of the barrier layer and the adhesion
layer that extend beyond the first solderable layer, the
diffusion barrier layer and the second solderable layer; and

forming at least one solder ball over the second
10 solderable layer.

13. The method of claim 12, further comprising forming
a polyimide layer around the barrier layer, the adhesion
layer, the first solderable layer, the diffusion barrier
15 layer and the second solderable layer.

14. The method of claim 12, wherein the step of
forming the barrier layer comprises sputtering.

20 15. The method of claim 12, wherein the step of
forming the adhesion layer comprises sputtering.

16. The method of claim 12, wherein the step of
forming the first solderable layer comprises electroplating.

17. The method of claim 12, wherein the step of forming the diffusion barrier layer comprises electroless deposition.

5 18. The method of claim 12, wherein the step of forming the second solderable layer comprises electroplating.

10 19. The method of claim 12, wherein the first solderable layer is made of Cu.

20. The method of claim 19, wherein the diffusion barrier layer is made of CoWP.

15 21. The method of claim 12, wherein the second solderable layer is made of Ni.

20 22. The method of claim 12, wherein the step of forming the lead-free solder ball comprises at least one of electroplating, solder screening, exchange plating, and electroless deposition.

23. A method for forming an interconnection structure for flip-chip attachment of microelectronic device chips to packages, comprising:

forming a barrier layer over a substrate;

5 forming an adhesion layer over the barrier layer;

forming a first solderable layer over the adhesion layer;

forming a diffusion barrier layer over the first solderable layer;

10 forming a second solderable layer over the diffusion barrier layer; and

forming at least one solder ball over the second solderable layer.

15 24. The method of claim 23, wherein the step of forming the first solderable layer comprises:

forming a resist layer over the adhesion layer, the resist layer having an opening that exposes the adhesion layer; and

20 electroplating the adhesion layer over the adhesion layer through the opening in the resist layer.

25. The method of claim 24, wherein the step of forming the diffusion barrier layer comprises electroless

deposition of the diffusion barrier layer over the first solderable layer through the opening in the resist layer.

26. The method of claim 25, wherein the step of
5 forming the second solderable layer comprises electroplating the second solderable layer over the diffusion barrier layer through the opening in the resist layer.

27. The method of claim 25, further comprising:

10 removing the resist layer after the first solderable layer, the diffusion barrier layer and the second solderable layer are formed; and

removing portions of the barrier layer and the adhesion layer that extend beyond the first solderable layer, the
15 diffusion barrier layer and the second solderable layer after the resist layer is removed.

28. The method of claim 23, further comprising forming a polyimide layer around the barrier layer, the adhesion
20 layer, the first solderable layer, the diffusion barrier layer and the second solderable layer.

29. The method of claim 23, wherein the diffusion barrier layer is made of CoWP.